An Insight Review on the Role of Fungi in Mastitis of Dairy Animals and Its Economical Importance

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Abstract
Mastitis, which has multiple and complex etiology, is a common syndrome among dairy industry. It is widespread in dairy herds and associated with a significant reduction in milk yield resulting in increased costs of production and deteriorated quality of milk and milk products. The initiative of this critical review manuscript was to assess the role of fungi in mastitis of dairy animals. According to some literature data, fungal infections in dairy animals account for 2%–13% of all cases of mastitis in dairy animals. However, the occurrence of mastitis depends on the interaction of host, agent, and environmental factors. The most frequently encountered fungi species in the pathology of mycotic mastitis in cows are: Candida spp., Aspergillus spp., Trichosporon spp., Cryptococcus spp., Penicillium spp., Cryptococcus neoformans, Rhodotorula spp., and Geotrichum candidum. Mycotic mastitis has become an increasing problem in animals and humans due to the wide use of antibiotics in mastitis therapy. Researches aimed on investigation on mycotic mastitis are required in relation to strict biosecurity practices as well as pattern of antibiotic therapy adopted for the treatment of these cases.

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1. Introduction

Among more than 72,000 described species of fungi that are widespread in nature (soil, plants, water, air), over 300 are now recognized as real or potential pathogens responsible for mycoses in humans and animals (Drouhet, 1998). Yeast is a microorganism, which may be found on a wide variety of substrates such as soil, plants and water. Several species of yeast have been reported to cause bovine mastitis (Richard \textit{et al.}, 1980). Mastitis is defined as an inflammation of the mammary gland; Mastitis usually occurs primarily in response to intramammary bacterial infection, but also to intramammary mycoplasmal, fungal, or algal infections. Mechanical trauma, thermal trauma, and chemical insult predispose the gland to intramammary infection (IMI). Occurrence of mastitis depends on the interaction of host, agent, and environmental factors (Pitkala \textit{et al.}, 2004).

Inflammation of mammary gland is the most important health problem in bovine dairy herds. The incidence of mastitis due to fungi is usually very low in dairy herds, but sometimes it can occur in epizootic proportions (Gonzalez, 1996). The symptoms of mastitis include abnormalities such as a watery appearance of milk, flakes, clots, or pus in milk (Krukowski, 2001). This disease can be identified by external symptoms such as swelling, heat, redness, hardness, or pain of the udder. Several species of yeast have been reported in many countries as causative agent of mastitis (Elad \textit{et al.}, 1995). Though moulds and yeasts are widely
Yeast infections should be suspected when there is a history of unsuccessful treatment or an intensification of clinical signs of mastitis after intramammary infusion of antibiotics (Schalm, 1971). Frequently, there is swelling of the affected gland, sometimes fever, marked reduction in milk production, and macroscopic abnormalities of the secretion. Cases of Candida usually recover spontaneously; however, spontaneous recovery after antibiotic therapy for mastitis caused by Cryptococcus is rare (van Veen, 1992). Although antimycotic drugs have been used for treatment of yeast mastitis (VanDamme, 1983), there is no clear evidence of the effectiveness of this therapy.

The most frequent isolated organisms among the Mycotic mastitis are the Candida species (Tarfarosh and Purohit, 2008) which are a group of unicellular opportunistic organisms, ever present in the natural surroundings of dairy cattle (milker’s hands, milking machines, treatment instruments, floor, straw, feed, dust, soil, drug mixtures, and sanitizing solutions) and are normal inhabitants of the skin of the udder and teats, in which they exist in low numbers (Santos and Marin, 2005). They can invade mammary glands and cause clinical mastitis characterized by pain, prolonged fever, tenderness, inflammatory reaction in the mammary gland and associated lymph nodes and reduction of milk yield and quality in animals (Şeker, 2010). Some intramammary fungal infections such as Aspergelllosis fumigatus and Candida Spp may result in death of affected animals (Krukowski et al., 2006).

Outbreaks of Myotic mastitis are generally not an unusual agent in bovine mastitis and are usually considered an environmental mastitis due to poor animal hygiene (Sheena et al., 1995) Bovine mycotic mastitis was reported (Costa et al., 1993) to be responsible for 1–12% of all mastitis cases. The environmental contamination with lack of hygiene during the milking and poor equipment cleaning leads to the development of mastitis. The use of antimicrobials for a long period is pointed out as the main factor that propitiates the occurrence of mycotic mastitis because they affect the micro flora of mammary gland. Infections by yeasts have been known both in animals and humans for years. Although the majority of mycotic mastitis in cows is mild, some cases may result in death. Excessive and erratic use of antibiotics, corticosteroids, immuno-suppressive drugs and chronic diseases are the major contributing factors in increasing the incidence of diseases due to yeasts (Watts, 1988). Therefore, the objective of this critical review manuscript was to assess the role of fungi species involved in mastitis of dairy animals and its economic importance in developing countries.

2. Fungal Etiology of Mastitis

The incidence of mastitis due to yeast sometimes occurred after intramammary infusion of antibiotics. The large doses of antibiotics may cause a reduction in the vitamin A, leading to injury to the udder’s epithelium, thus facilitating the invasion of fungi (Krukowski et al., 2000). Teat injuries may facilitate a yeast infection too (Gonzalez, 1996).

Mycotic mastitis had been documented to be caused by various genera of yeasts. However, the most frequently encountered species are Candida spp., Trichosporon spp., Cryptococcus spp., Saccharomyces spp., Aspergillus spp (Costa et al., 1993; Krukowski et al., 2006). Yeast infections of the mammary glands are responsible for 2–3% of clinical mastitis. Aspergillus fumigatus and A. nidalans have also been described as causal agents of bovine mastitis (Schallibaum et al., 1983). In over the quarters of cases, the cause of bovine mycotic mastitis is Candida species such as C. albicans, C. glabrata, C. kefyr, C. tropicalis, C. krusei, C. parapsilosis. Most of them are able to grow at 40° C (Lagneau et al., 1996). Cryptococcus neoformans (Schalm, 1971) and Candida albicans are by far the commonest causes but other Candida species have also been associated with bovine mastitis (Yeh, 1988).

3. Methods of Sample Collection

Quarter milk (inflamed secretion) samples were collected aseptically. The teat ends were cleaned with alcohol swabs and allowed to dry. The first few streams were discarded and then 2 – 4 ml of secretion was collected in sterile tubes. Samples were cooled and immediately transported to the laboratory.

4. Laboratory Diagnosis Approach

The most important work in the history of mycology was the work of Sabouraud, his medium for the identification of fungi still bears his name. Sabouraud’s medium is generally accepted and commonly used (Drouhet, 1998). Clinical mastitis was diagnosed by changes in the udder and milk compositions. Changes in the udder included pain, swelling, warmth and abnormal appearance (blood tinged milk, watery secretions, clots, pus) of milk. Cows that did not have clinical mastitis were subjected to further investigation for subclinical mastitis by using CMT. The procedures and...
interpretations were performed according to Quinn et al., (1994). Isolation of Cryptococcus neoformans was carried out on sunflower seed agar medium (SFA) and Sabouraud dextrose agar (Pal M et al., 1990) According to Abdo Elgabbar, et al., (2011) direct smears were stained with gram stain. Representative parts of the specimens were inoculated in duplicates onto Sabouraud Dextrose Agar (SDA) with chloromphinicol (0.05 mg/ml) and Malt Extract Agar (MEA) with chloromphinicol (0.05 mg/ml). Slopes and plates are incubated at 26º C and 37º C. The cultures are examined daily and observations were recorded. Further confirmatory tests are conducted using Corn Meal Agar (CMA) with tween 80, germ tube production test using equine serum, and urease test. Multiplex PCR to be a simple, sensitive and specific test for the direct diagnosis of bovine mycotic mastitis (El-Razik et al., 2011).

Table 1: Fungi isolated from the mammary secretion of lactating cows and buffaloes according to: (Krukowski and Saba, 2003)

<table>
<thead>
<tr>
<th>Genera</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhodotorula</td>
<td>R. glutinis, R. minuta, R. rubra</td>
</tr>
<tr>
<td>Trichosporon</td>
<td>T. cutaneum (T. beigeli), T. asahii</td>
</tr>
<tr>
<td>Cryptococcus</td>
<td>C. albidus, C. curvatus, C. flavus, C. laurantii, C. luteolus, C. neoformans</td>
</tr>
<tr>
<td>Aureobasidium</td>
<td>A. pullulans</td>
</tr>
<tr>
<td>Pichia</td>
<td>P. ohmeri, P. membranaeaciens, P. farinosa, P. toletana, P. rhodanensis</td>
</tr>
<tr>
<td>Geotrichum</td>
<td>G. candidum, G. capitatum (Blastoschizomyces capitatus)</td>
</tr>
<tr>
<td>Saccharomyces</td>
<td>S. fragilis, S. marxianus</td>
</tr>
<tr>
<td>Debaromyces</td>
<td>D. hansenii</td>
</tr>
<tr>
<td>Hansenula</td>
<td>H. fabianii, H. holsiti, H. polymorpha, H. anomala</td>
</tr>
<tr>
<td>Aspergillus</td>
<td>A. fumigatus, A. flavus, Aspergillus sp.</td>
</tr>
<tr>
<td>Penicillium</td>
<td>P. chrysogenum, P. cyclopium (P. aurantiogriseum), Penicillium sp</td>
</tr>
<tr>
<td>Alternaria</td>
<td>Alternaria sp.</td>
</tr>
<tr>
<td>Epicoccum</td>
<td>Epicoccum sp</td>
</tr>
<tr>
<td>Phoma</td>
<td>Phoma sp.</td>
</tr>
</tbody>
</table>

5. Epidemiology of fungal mastitis in dairy animals

Mastitis causes heavy economic losses to the dairy industry worldwide. The reduction in milk production attributed to subclinical mastitis may account for 70%-80% of the total losses (Philpot and Nickerson, 1991). The economic significance of the disease varies among herds and to some extent depends on the system of management and degree of intensification. Some public health importance, since occasionally milk harboring human pathogens may cause infection to the consumers of raw or inadequately heated milk. Mastitis remains unsolved problem because of its complex etiology (Harby et al., 1991).

Fungal infections are predominantly caused by yeasts of the genus Candida (Watts, 1988) and The percentage of bovine mycotic mastitis in surveys carried out in many countries varies considerably between 1 to 25%, with 1.3% rates reported in South Korea (Yeo and Choi, 1982), 1.3% in Denmark (Aalbaek et al., 1994), 2 to 7% in central, northern Europe and in the USA (Kirk and Bartlett, 1986; Aalbaek et al., 1994). In tropical countries, the percentage can be higher such as in Brazil (12.07 to 25.43 %) as reported by Costa et al. (1993) and Dos Santos and Marin (2005) 9.6% in Poland (Krukowski et al., 2000), 6.2% in Greece (Bourtzi-Hatzoupoulou et al., 2003), 25.2% in Egypt (El-Razik et al., 2011). Candida albicans, Candida parapsilosis and Candida guillermondii had also been isolated from camel mastitis in Sudan (Amel, 2000).

6. Distribution

Yeast is a microorganism, which may be found on a wide variety of substrates such as soil, plants and water. Most of these organisms are opportunists and sources of infection include the skin of the udder, udder secretion, milker’s hands, milking machines, treatment instruments, floor, straw, feed, dust, soil, drug mixtures and sanitizing solutions (Richard, 1980). They can invade mammary
glands, where they are opportunistic, producing disease when normal defense mechanisms are lowered.

7. Economic importance of fungal mastitis

Various expenses like decreased in milk production, veterinary treatment cost, increased labour charges are compound conditions where culling become necessary. In dairy production, improved management and different control measures have greatly decreased the incidence and prevalence of contagious mastitic organisms. Inflammation of mammary tissue (mastitis) is a multifarious disease that affects dairy animals, causes huge economic losses decreasing 3-5 % milk production, and impairs its quality, which indicates serious risk to human health (Costa, 1998; Marjan et al., 2009). While investigating the total expenses that are involved in mastitis prevention, its treatments scientists have determined some strategies based on the direct impacts of disease. Miller et al., (1993) determined cost of mastitis prevention, which was $14.50 per animal annually. Kossaibati and Esselmont (1997) reported that average cost per animal infected with mastitis is £218 in England. Singh (1976) reported that mastitis acts as economically devastating disease and hamper in desired production in dairy industry. Economic losses due to mastitis may be divided into lower milk production 70%, discarded milk due to veterinary medication 8%, the cost of which is significantly more than the cost milk which is not produce, treatment and veterinary charges 8% and premature culling 14% (Barkema et al., 2006; Halasa et al., 2007). For instance, DeGraves and Fetrow (1993) estimated $2 billion total costs used in curing bovine mastitis.

7.1 Treatment of fungal mastitis

Treatment of mycotic mastitis is a challenge, as many of these fungi do not respond to the antibiotics therapy rather they use some of the antibiotics like tetracycline as their source of energy (Tarfarosh, 2008). In vitro antymycotic sensitivity of yeasts isolated from infected bovine mammary glands was studied in yeast cultures. These cultures were most sensitive to clotrimazole followed by ketoconazole, nystatin, miconazole and amphotericin B and least sensitive to 5-fluorocystine. The most sensitive yeast was C. lusitaniae (85.7%) and the least sensitive was C. rugosa (31.9%) (McDonald et al., 1980). Cure rates of 78–80% were obtained (VanDamme, 1983). A case of bovine mycotic mastitis caused by A. fumigatus was successfully treated by combined intra-arterial and intramammary injection on three successive days of the antifungal drug miconazole. After evening milking 100 mg of miconazole (10 mL) was injected into the right external pudendal artery. Miconazole diluted with 50-mL saline was also infused into the affected udder (Katamoto & Shimada, 1990). As El-Razik et al., (2011) reported Lactobacillus rhamnosus and Bifidobacterium isolated from cow milk showed antifungal activities against C.albicans and A.fumigatus with zone of inhibition equal (12, 10) and (10, 9) mm respectively. Also Feio et al., (2004) proved that Bacillus subtilis inhibited the growth of several fungi. Magnusson et al., (2003) found that Lactobacillus salivarius, L. plantarum and Pediococcus pentosaceus strains inhibited some fungi. L. acidophilus indicated that the antifungal effect of these lactic acid bacteria could not simply be assigned to the low pH, but most probably to the formation and secretion of antifungal organic metabolites.

Limitation of the Research

Recent researches conducted on mastitis causing pathogens and showing the specific economic significance were not available. As a result, I have faced with many difficulties to search for updated information regarding to these mastitis causing fungi species and its global impact. This critical manuscript is organized using the available literatures in the previous time. I hope that this would be creating limitation on this research work.

Conclusion and recommendations

Early diagnosis of sub-clinical mastitis with reliable tests facilitates successful treatment and control. The environmental contamination associated with lack of hygiene during the milking and poor equipment cleaning leads to the development of mastitis. Mycotic mastitis has become an increasing problem due to the wide use of antibiotics in mastitis therapy. The effects of mastitis on dairy animals’ health and milk production highlight an urgent need to develop effective strategy of prevention and control. The constantly changing predominance of etiological agents in different geographical locations must be considered while adopting and developing mastitis control strategies. Research aimed on investigation on the mycotic mastitis is required in relation to the hygienic and management practices as well as pattern of antibiotic therapy adopted for the treatment of these cases and also effort should be encouraged to apply substitutes of antimicrobials such as probiotics and bioactive natural compounds for prophylactic and therapeutic use since mastitis has high public health hazard. Good hygiene and sanitation practices of animal farm and judicious use of antibiotics will lower incidence of bovine mycotic mastitis.
Declaration

We, the undersigned, declare that this critical review manuscript is our original work and has not been conducted and published by other authors/researchers yet.

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Authors’ contribution

All the authors contributed equally for this study. All authors read and approved the final manuscript for publication.

Competing interests

Authors declare that they have no competing interest.

References


Krukowski H, Tietze M, Majewski T, Rózanski P. 2000. Survey of yeast mastitis in dairy herds of small-type farms in the Lublin region, Poland. Mycopathologia; 150, 5-7


Şeker E., 2010. Identification of Candida Species isolated from Bovine mastitic milk and there in vitro hemolytic activity in Western Turkey. Mycopathologia 169, 303-308


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